Claims

1. Device for transportation of a flowing medium and/or for heat exchange between a flowing medium and the device, characterized in that
at least one surface of the device is provided with a plurality of dimples.

2. Device according to claim 1, wherein the dimples are arranged periodically.

3. Device according to one of the preceding claims, wherein the centers of three adjoining dimples form an equilateral triangle, the distance between the centers of two neighboring dimples having a constant value t_2 and the distance between two consecutive rows of dimples having a constant value t_1.

4. Device according to one of the preceding claims, wherein the dimples have a two-dimensional edge.

5. Device according to one of the preceding claims, wherein the dimples are rounded at the edge towards the remaining surface.

6. Device according to one of the preceding claims, wherein the dimples essentially have the form of a section of a sphere or an ellipsoid.

7. Device according to one of the preceding claims, comprising a transport channel, wherein the at least one surface with dimples is provided as the inner surface of said transport channel.

8. Device according to claim 7, wherein said transport channel essentially has the form of a pipe.

9. Device according to one of the preceding claims, wherein the at least one surface is provided such that in the proximity to the at least one surface vortices are formed in a medium, when the medium flows along the at least one surface.

10. Device according to one of the preceding claims, wherein the deposition of particles on said at least one surface having a periodic dimple structure is reduced in comparison to a flat surface, when a medium flows along the surface.

11. Device according to one of the preceding claims, wherein the formation of ice on said at least one surface having a periodic dimple structure is reduced in comparison to a flat surface, when a medium flows along the surface and the surface has a lower temperature than the medium.

12. Surface along which a medium flows, said medium consisting of a gas, a liquid, a two-phase mixture, or a mixture of multiple phases, characterized in that said surface comprises dimples, wherein the edges of said dimples are rounded, thereby forming a central dimple area and at least one curvature area for each dimple, which continuously connects the dimple to the surrounding surface.

13. Surface according to claim 12, wherein said central dimple area essentially has the form of a section of a sphere or an ellipsoid.

14. Surface according to claim 12 or 13, wherein said curvature area comprises at least a first curvature area and a second curvature area, the first curvature area having a different curvature than the second curvature area.

15. Surface according to claim 14, wherein said first curvature area is rounded with a first rounding radius and said second curvature area is rounded with a second rounding radius.

16. Surface of claim 15, wherein the central dimple area essentially has the form of a section of a sphere, and the form of the central dimple area, of the first curvature area and of the second curvature area in a cross section perpendicular to the surface and through the center of the dimple is defined by the following parameters:

d_1: Diameter of the central dimple area,

d_2: Outer diameter of the first curvature area,

t_1: Outer diameter of the second curvature area,

R_1, C_1: Radius and center point of the sphere, the section of which forms the surface of the central dimple area,

R_2, C_2: Radius and center point of the rounding radius of the first curvature area,

R_3, C_3: Radius and center point of the rounding radius of the second curvature area,

P_1: Transition point from the central dimple area to the first curvature area,

P_2: Transition point from the first curvature area to the second curvature area,

P_3: Transition point from the second curvature area to the surrounding surface,

h_1: Difference in height between the lowest point of the central dimple area and the outer rim of the central dimple area,

h_2: Difference in height between the inner rim of the first curvature area and the outer rim of the first curvature area,

h_3: Difference in height between the inner rim of the second curvature area and the outer rim of the second curvature area,

α_1: Angle between the y-axis and a line connecting C_2 and C_3,

α_2: Angle between the x-axis and a line connecting C_1 and C_2,

f: Parameter related to the portion of the surface covered by the central dimple area in relation to the combined area of central dimple area and curvature areas,

wherein a set of parameters, in particular the parameters d_1, α_1, α_2, R_2/R_1 and f, are chosen and the remaining parameters are calculated by means of the following equations with a tolerance of ± 10% for each parameter:

$$R_1 = \frac{d_1}{2 \cdot \sin \alpha_1},$$

$$R_2 = \frac{R_2}{R_1} \cdot \frac{d_1}{2 \cdot \sin \alpha_1},$$

$$R_3 = \frac{t_1 - \frac{d_1}{2} \cdot \frac{R_2}{R_1} \cdot \frac{(1 - \sin\alpha_1)}{\sin\alpha_2}}{\sin\alpha_2},$$

$$h_1 = \frac{d_1}{2} \cdot \frac{(1-\cos\alpha_1)}{\sin\alpha_1},$$

$$h_2 = R_2 \cdot (\cos\alpha_2 - \cos\alpha_1),$$

$$h_3 = R_3 \cdot (1-\cos\alpha_2),$$

$$H = h_1 + h_2 + h_3,$$

$$t_1 = \sqrt{\frac{\pi}{6 \cdot f}} \cdot d_1,$$

$$C_1 = (X_{C1}, Y_{C1}) \text{ with } X_{C1} = 0, \quad Y_{C1} = R_1 - H,$$

$$C_2 = (X_{C2}, Y_{C2}) \text{ with } X_{C2} = \frac{d_1}{2} \cdot \left(1 + \frac{R_2}{R_1}\right), \quad Y_{C2} = R_3 + \frac{X_{C3} - X_{C2}}{tg\alpha_2},$$

$$C_3 = (X_{C3}, Y_{C3}) \text{ with } X_{C3} = \frac{t_1}{2}, \quad Y_{C3} = -R_3,$$

$$P_1 = (X_{P1}, Y_{P1}) \text{ with } X_{P1} = \frac{d_1}{2}, \quad Y_{P1} = H - h_1,$$

$$P_2 = (X_{P2}, Y_{P2}) \text{ with } X_{P2} = \frac{t_1}{2} - R_3 \cdot \sin\alpha_2, \quad Y_{P2} = R_3 \cdot (\cos\alpha_2 - 1),$$

$$P_3 = (X_{P3}, Y_{P3}) \text{ with } X_{P3} = \frac{t_1}{2}, \quad Y_{P3} = 0,$$

said equations being defined in a two-dimensional coordinate-system with the x-axis in the plane of the surface and with the y-axis through the center of the dimple and perpendicular to the surface.

17. Surface according to any of the preceding claims, wherein said dimples are arranged periodically on said surface.

18. Surface according to any of the preceding claims, wherein the centers of three adjoining dimples form a triangle, the distance between two neighboring dimples having a constant value t_1 and the distance between two rows of dimples having a constant value t_2.

19. Surface according to claim 18, wherein the curvature areas of said three adjoining dimples are in contact with each other.

20. Surface according to claim 18 or 19, wherein additional dimples of a different size are provided, which are located in the center of three respective adjoining dimples.

21. Surface according to any of the preceding claims, characterized by a reduced particle deposition on said surface.

22. Surface according to any of the preceding claims, characterized by a reduced ice formation on said surface.

23. Surface according to any of the preceding claims, characterized by a reduced friction resistance.

24. Surface according to any of the preceding claims, characterized by an increased heat transfer between said surface and said flowing medium.

25. Device for transportation of a medium, comprising at least one surface with dimples according to one of claims 12 to 24.

26. Device according to claim 25, comprising a transport channel, wherein the at least one surface with dimples is provided as the inner surface of said transport channel.

27. Device according to claim 26, wherein said transport channel is a pipe.

28. Device according to one of claims 25 to 27, characterized in that the deposition of particles on said at least one surface is reduced in comparison to an otherwise identical device with a flat surface.

29. Device for heat exchange between a flowing medium and at least one surface of the device, wherein the at least one surface is provided with dimples according to one of claims 12 to 24, in particular provided as a part of an air-conditioning system.

30. Device according to claim 29, characterized in that the forming of ice on said at least one surface is reduced in comparison to an otherwise identical device with a flat surface.

31. Layer for applying on a surface, wherein said layer comprises a surface with dimples according to one of claims 1 to 13.

32. Layer according to claim 31, having a first side and a second side, characterized in that said first side comprises dimples according to one of claims 12 to 24 and said second side is self-adhesive.

33. Method for producing a surface with reduced particle deposition and/or reduced ice formation and/or reduced friction resistance and/or improved heat exchange with a surrounding medium, comprising the step of
- applying a layer according to claim 31 or 32 onto said surface.

34. Method for producing a surface with reduced particle deposition and/or reduced ice formation and/or reduced friction resistance and/or improved heat exchange with a surrounding medium, comprising the steps of
- providing a workpiece with at least one surface and
- imprinting into said at least one surface a structure comprising dimples, in particular generating a surface according to one of claims 12 to 24.

35. Method for producing a surface with reduced particle deposition and/or reduced ice formation and/or reduced friction resistance and/or improved heat exchange with a surrounding medium, comprising the steps of
- providing a casting mold with at least one structured surface and
- molding, in particular injection molding, of a workpiece with at least one surface comprising dimples, in particular a surface according to one of claims 12 to 24, by means of said casting mold.

36. Application of a surface according to one of claims 12 to 24 as a surface of
- a device for transportation of a medium or
- a device for heat exchange.

37. Application of a device according to one of the claims 1 to 11 or 25 to 30 in an air-conditioning system.

38. Application of a surface comprising a plurality of dimples as a surface of a flow channel for reducing the deposition of particles, when a medium flows along the surface.

39. Application of a surface comprising a plurality of dimples as a surface of a flow channel for reducing ice formation, when a medium flows along the surface.

40. Air-conditioning system for cooling a heat exchange medium, comprising at least one flow channel for the heat exchange medium, wherein the flow channel is in particular provided as a device according to one of the claims 1 to 11 or 25 to 30, the inner surface of said at least one flow channel being provided with a plurality of dimples.